

APPENDIX H

HYDROPOWER EVALUATIONS CONSIDERATIONS

H-1. The following provides additional information specifically for preparing hydropower major rehabilitation evaluation reports. The definitions provided in the guidance are general in nature. The terminology used in these definitions may have different meanings within the power industry.

H-2. Reliability. For a hydropower project reliability can be further defined as the extent that the generating equipment can be counted on to perform as originally intended. This includes (1) the confidence in the integrity of the equipment based on maintenance cost, availability and forced outage experience; (2) the output of the equipment in terms of energy, power output, and efficiency (restoration of lost output); and (3) the dependability of the equipment in terms of remaining service life (retirement of equipment).

H-3. Efficiency Improvement. This category is synonymous with uprating within the hydropower industry. This involves increasing the project's output, in terms of energy and/or capacity, beyond the original design. For reports submitted under this program and guidance, the efficiency improvement (uprating) category should be used in connection with correction of a reliability problem in that any proposed efficiency improvement (uprating) would be taking advantage of the economic opportunities available. In many cases a reliability driven rehabilitation project for a hydropower plant will have some incidental increase in outputs (capacity and/or energy) due to improvement in technology. Such incidental increases should be documented as to what additional costs, if any, are incurred, and what portion of the benefits are attributable to the efficiency improvement (uprate). Presently uprating of power plants in the absence of an identified and quantified reliability problem have low priority in this program.

H-4. Reliability/Risk Analysis. The reliability/risk analysis for hydropower (and other electro-mechanical) equipment takes a different form than what is used for structures. Much of the hydropower analysis is based on a function of equipment condition indices and survivor curves, instead of the β calculations discussed in this guidance. The reliability analysis for hydropower equipment should be prepared by the Hydroelectric Design Center (CENPD-PE-HD), in accordance with ER 1110-2-109.

H-5. O&M Costs and Test Data. As a part of the evaluation report all relevant O&M costs needs to be presented. The more historical cost data that is available the better the future projections. These costs are especially important for auxiliary equipment that may not have a major impact on power revenues or benefits.

a. Field test data for turbines and generators is mandatory to demonstrate the loss of efficiency and/or capability. Test data on each unit is desirable. However, if it is not practical to obtain individual data, an explanation of the rationale used to apply the assumed condition or performance of untested equipment is needed.

b. All test data must be presented in a format that will show the results, the go/no go values and the conclusions. A narrative on what tests were performed and the results will be useful for the non-technical reviewer. Where appropriate, the complete test data may be submitted with the report as an appendix or as a separate report.

H-6. Analysis of Existing Facilities. In order to fully develop an evaluation report, an analysis of the existing components that will be affected by the proposed work is to be performed. Even if the proposed work does not include an uprating of project capacity, a review of the existing facilities is necessary. The required power train analysis is commonly referred to as "water to wire." The economics of an uprating can be adversely affected by the necessity of replacing a main power transformer or a turbine shaft and bearings because of inadequate component capacities.

A partial list of items to be analyzed:

- penstock water hammer
- turbine and generator shafts and couplings
- excitation equipment capacities
- stator winding capabilities
- equipment cooling requirements
- power transformer rating
- unit and switchyard switchgear

H-7. Economic Analysis. The economic analysis for hydropower major rehabilitation evaluation is based on losses or gains in capacity and energy and avoided repair and O&M expenses. By not doing the proposed rehabilitation, there will be a cost associated with the reduced reliability of the power unit. Benefits can be lost by not restoring lost efficiency or taking advantage of additional capacity and/or efficiency. A regional power benefits model must be used to reflect the value of energy and capacity for the project being evaluated.

a. Realistic increases in capacity and efficiency must be presented. The results of the power train analysis will show if there are additional modifications (and costs) associated with the proposed project. For turbine replacements a sensitivity analysis is needed to show the affects of a range of efficiencies, instead of assuming the highest possible value. Not all turbine replacements are going to achieve 95% efficiency.

b. At this point in the development of the hydropower evaluation guidance, not all types of equipment have well defined risk assessment methodologies. This, coupled with the issue of separable elements of a power plant, leaves many major auxiliary components without fully developed procedures. Efforts should be made to quantify NED benefits associated with the replacement of a voltage regulator, hydraulic governor, alarm system and the like. Also, give other justification if these benefits can not be economically quantified or justified.